DEVELOPING AN EXIT STRATEGY TO FACILITATE THE REMEDIAL DECISION PROCESS

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Introduction

An "exit strategy" is simply a description of the information that will be used to demonstrate that the desired performance for any selected environmental remedy has been achieved, the response objectives have been met, and the associated activities can be terminated. An exit strategy is particularly important for any activity that is performance- or results-based (e.g., long-term groundwater remedies), as opposed to design-based (e.g., a soil removal action), because it defines the data that will be necessary and sufficient to document that the desired performance has occurred. It often is difficult to develop comprehensive exit strategies because the problem to be addressed has not been clearly stated. In many cases, inadequate problem definition can lead to difficulties addressing the problem, addressing the wrong problem (e.g., dealing with a "symptom" rather than the cause), or addressing a problem at significantly greater cost – and a significantly longer timeframe - than was technically necessary. These issues can generate confusion (and lack of consensus) among stakeholders about the ultimate remedial objectives, and often contribute to a foreshortened decision process wherein "getting a remedy in place" becomes the objective, and little thought is given to actually completing the response action and closing (e.g., de-listing) the site.

Discussion

Recent Defense Environmental Restoration Program (DERP) guidance (DoD, 2001), which is modeled on the CERCLA Superfund paradigm, lays out the goals of environmental restoration (ER) and a process to achieve those goals. These goals are:

1) Reduce risks to human health and the environment.
2) Make the DoD property suitable for transfer.
3) Put final remedies in place and complete response actions; and
4) Expedite termination of Department of Defense (DoD) funded environmental liabilities by completing specific stages of the response process by specific dates.

The lack of perceived progress toward achieving Goal 1 has resulted in mandated schedules that emphasize mechanistic milestones in the ER program (Goal 4), such as signing a Record of Decision (ROD) and completing remedial design (RD), in order to install and begin operating a remedial system (remedial action, or RA). This rush to program milestones by Components in an attempt to clearly demonstrate to DoD, Congress, and the public that "something is being done" to protect the public welfare, and to justify the expenditure of taxpayer dollars, often has created a myopic view of the ultimate goal of the DERP – and of the CERCLA process. This goal is to complete all response actions (Goal 3) at each installation. Response complete (RC) requirements include confirmation that all remedial action objectives (RAOs) have been achieved (through a series of formal RA inspections), and submittal of a final site closeout report (FCOR). However, little thought is given to how the effectiveness of a selected remedy will be tracked through time, and numeric RAOs often are tied to default regulatory standards such as maximum contaminant limits (MCLs), even when such levels are neither required to ensure protectiveness of the remedy, nor are likely to be achievable in a reasonable timeframe. AFCEE and DLA have implemented the Remedial Process Optimization (RPO) initiative in response to DERP directives, and as an investment in "smarter/faster/cheaper" solutions to ER problems.

The CERCLA process, which is generally adopted by the DERP, begins with a preliminary assessment (PA) to identify potential sites with facility-related environmental concerns, and implementation of emergency interim response actions (IRAs) where necessary, and progresses through remedial investigation (RI) to fully characterize site conditions and the nature and extent of contaminants requiring a response action, feasibility study (FS) to identify and evaluate candidate technologies and strategies to be used to address the identified contamination, a decision document to articulate the selected plan for achieving site closure, RD/RA to implement the selected remedy, operations and maintenance (O&M) of the RA and tracking of progress toward achieving the RAOs, and culminating with site closure, when all the RAOs have been met. While ideally envisioned as a step-wise process, the CERCLA/DERP process can become excessively iterative if a clear path forward is not articulated – preferably early in the process. For example, if the RI does not fully characterize all site conditions, including physical, chemical, and environmental factors, that can influence contaminant behavior and remedy performance, the resulting incomplete understanding of the conceptual site model can lead to selecting inappropriate technologies for the RA, and identifying RAOs that may be unachievable within a reasonable time frame. These deficiencies may not become evident until the remedy has been in the RA O&M phase for years (e.g., during a Five-Year Review), at which time another round of data collection may be required, the RA may require modification, and cost- and schedule-to-complete (CTC and STC) estimates may be challenged, thereby essentially kicking the ER program back into RI/FS, and requiring amendment of the decision documents. In such cases, there are two methods to refocus the ER program on the RC objective: use the better understanding of the site to change the remedial technology to better address actual conditions (technology contingency planning), and/or change the RA endpoints to more realistic and achievable RAOs, such as protective alternate concentration limits (ACLs) (endpoint contingency planning).

Clear statement of the problem, predicated on comprehensive site information, is the foundation of a defensible, implementable exit strategy. In addition to clear problem statement, a sound exit strategy will have the following components: 1) development of RAOs that are protective and achievable, 2) development of a remedy performance model that allows prediction of remedy effectiveness in the context of well-characterized site conditions, 3) development of performance metrics that allow progress toward and attainment of RAOs to be measured, and 4) contingency plans that define and address potential deviations from the expected remedy performance, specify the triggers for implementation of the contingency plan, and identify alternative response actions.

Case Examples

The presentation reviews the key elements of a well-defined exit strategy, and illustrates the process by describing two case examples. One example describes a remedy-specific exit strategy for vadose-zone soils, and the other reviews recent RPO recommendations for a groundwater exit strategy at a complex Defense Logistics Agency (DLA) installation in Virginia. The Castle Air Force Base soil-vapor extraction (SVE) Termination or Optimization Process (STOP) protocol, developed to guide closeout of sites in California with volatile organic compound (VOC) contamination in unsaturated soils that is being treated using SVE, is briefly reviewed as an example of an exit strategy for a particular technology. The STOP protocol develops decision criteria and a suite of 13 evaluation STOP “elements” that use risk and performance data and cost/benefits analyses to determine when an SVE system can be shutdown, or if it can be optimized to accelerate attainment of closure (RC) criteria. California state regulatory authorities and Region 9 of the US Environmental Protection Agency have endorsed the STOP protocol for multiple Department of Defense (DoD) facilities in the Central Valley.

In a March 1998 report (No. 98-090) issued by the Office of the Inspector General (IG), the IG concluded that groundwater pump-and-treat systems are ineffective and costly, and directed DoD Components to re-evaluate pump-and-treat systems to identify cost and performance optimization opportunities, and to identify more effective, alternative methods for groundwater cleanup. Pursuant to this directive, and to revised DERP guidance, DLA, with assistance from the Air Force Center for Environmental Excellence (AFCEE), has implemented an RPO initiative at its facilities to identify “smarter, faster, and cheaper” ER solutions. The ER program at the Defense Supply Center – Richmond (DSCR) is currently undergoing an RPO evaluation. Groundwater at DSCR is contaminated with chlorinated aliphatic hydrocarbons (CAHs) and exhibits elevated concentrations of several inorganic constituents. An interim groundwater pump-and-treat system was installed in 1996 to slow the off-site migration of CAHs in the central part of the installation, to initiate CAH mass removal, and to reduce risks. Because the treatment system (air stripper) addresses only volatile chemical of potential concern (COPCs), inorganic COPCs are uncontrolled, and may be adversely affecting IRA system components and receiving surface waters. Hydrogeologic and IRA performance data suggest that local hydrostratigraphic conditions in the upper water-bearing unit preclude containment through extractive technologies, and the extraction system in the lower unit is achieving only partial containment. Off-facility contamination is not being fully captured by the IRA system, and upgradient source concentrations of CAH have been minimally affected during 6 years of system operation. Although final RAOs have not been established for DSCR groundwater, IRA decision documents suggest a predisposition to the use of MCLs as cleanup goals, and regulators have stated a strong desire to adopt the IRA as the final groundwater remedy. Available data on system performance indicate that, at the current mass-removal rates, this technology would not achieve MCLs - even if it were operated in perpetuity. During the RPO evaluation for DSCR, an exit strategy incorporating spatially determined ACLs, alternative *in-situ* treatment and containment technologies, performance metrics to assess RA O&M progress, and contingency plans to be triggered by performance based criteria has been proposed to supplement an optimized pump-and-treat system. By altering cleanup goals to ACLs that are achievable and protective, and by incorporating innovative approaches into the final remedy for groundwater, RC can be achieved in a reasonable timeframe. Because time equals money, a finite RA O&M phase will ensure a more cost-effective ER. The requirement for and effects of a well-defined exit strategy on CTC and STC estimates also are briefly reviewed.